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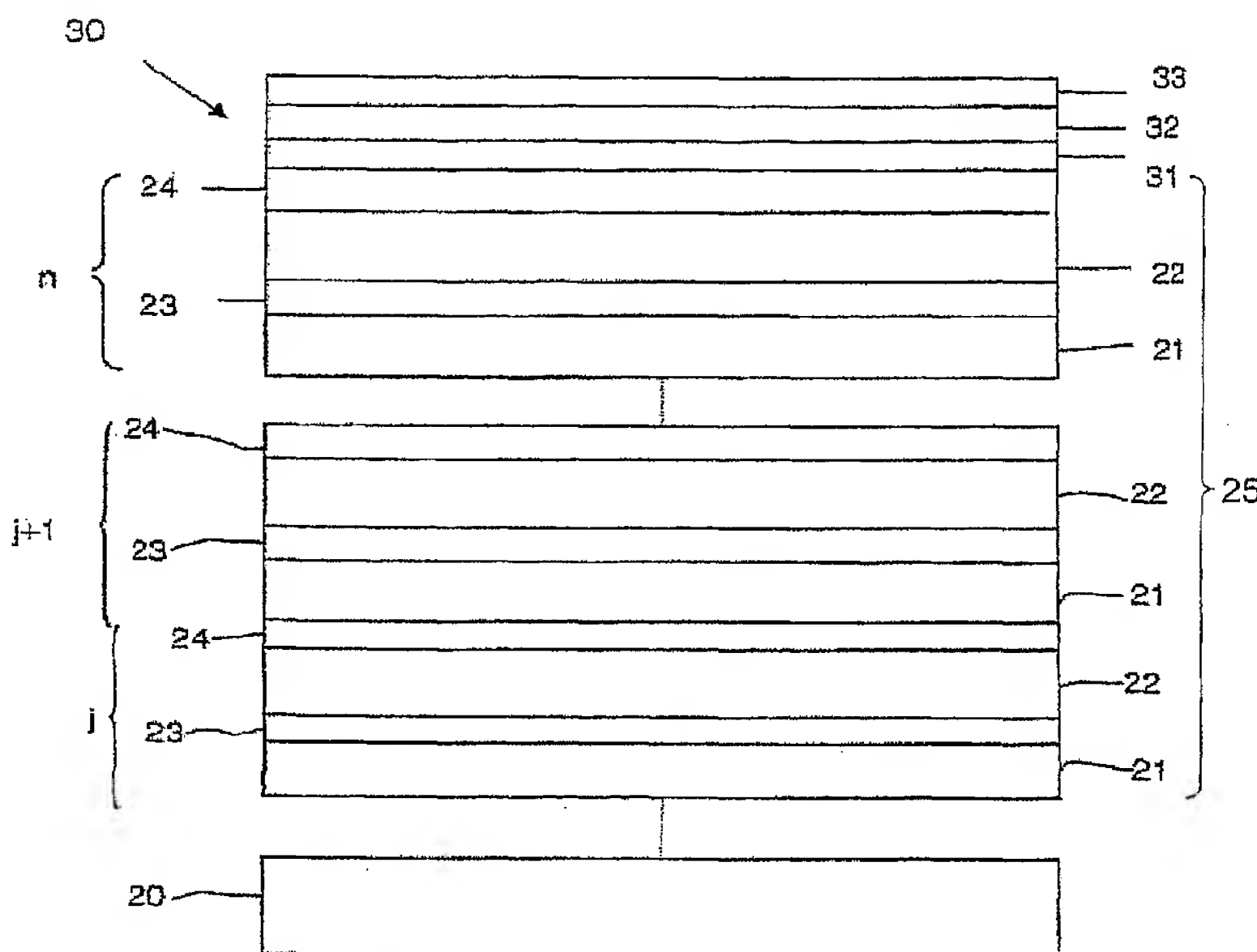
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(54) Title: METHODS FOR MANUFACTURING REFLECTIVE OPTICAL ELEMENTS, REFLECTIVE OPTICAL ELEMENTS, EUV-LITHOGRAPHY APPARATUSES AND METHODS FOR OPERATING OPTICAL ELEMENTS AND EUV-LITHOGRAPHY APPARATUSES, METHODS FOR DETERMINING THE PHASE SHIFT, METHODS FOR DETERMINING THE LAYER THICKNESS, AND APPARATUSES FOR CARRYING OUT THE METHODS



(57) Abstract: The invention relates to a method for manufacturing of a multilayer system (25) with a cap layer system (30), in particular for a reflective optical element for the extreme ultraviolet up to the soft x-ray wavelength range, comprising the steps of: 1. preparing a coating design for the multilayer system (25) with cap layer system (30); 2. coating a substrate (20) with the multilayer system (25) with cap layer system (30); 3. spatially resolved measurement of the coated substrate in terms of reflectance and photoelectron current in at least one surface point; 4. comparison of the measured data with data modelled for different thicknesses of the layers (31, 32, 33) of the cap layer system (30) and/or the layers (21, 22, 23, 24) of the multilayer system (25) for determining of the thickness distribution obtained by the coating; 5. if necessary, adjusting of the coating parameters and repeating steps 2 to 5 until the coated thickness

distribution coincides with the design. The invention also relates to further manufacturing methods, reflective optical elements, EUV-lithography apparatuses, and methods for operating optical elements and EUV-lithography apparatuses as well as methods for determining the phase shift, methods for determining the layer thickness, and apparatuses for carrying out the methods.

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